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MARINE ENVIRONMENTAL DATA SERVICES BRANCH

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APPLICATIONS SOFTWARE: OBJECTIVE DESCRIPTION OF THE THERMOCLINE

J. NASR

Marine Environmental Data Services Branch

Fisheries and Oceans Canada

F.-R. BOUDREAULT

Research and Planning Branch

Environmental Protection Services of Quebec

DEPARTMENT OF FISHERIES AND OCEANS

OTTAWA, CANADA

RESUME

Un logiciel d'application a été mis sur pied en 1977 pour la description de la thermocline de chaque profil d'une série d'observations bathythermographiques. Dans ce rapport nous décrivons le logiciel, son mode d'emploi et donnons quelques exemples d'analyses possibles. Le logiciel fait appel à la définition de la thermocline suggérée par Boudreault et Laprise en 1973.

ABSTRACT

An application program was implemented in 1977 to describe the thermocline of each profile of a set of bathythermograph observations. We describe in this report the operation of the program and we illustrate the use of the output in some analyses. The program uses the definition of the thermocline as suggested by Boudreault and Laprise in 1973.

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1. BACKGROUND

Illustrations of the permanent thermocline probably date back to the CHALLENGER expedition (Tizard, 1884), but the vertical spacing of the observations was generally such that little or no seasonal structure appeared at the few stations in the northwest Atlantic in May 1883. It can already be noted, however, that "... the rate of decrease of temperature with increase of depth diminishes ..." (Tizard et al., 1885).

At the time of the Danish INGULF expedition the vertical spacing of the observations was made small enough for the presence of a more complex structure to be noted. Knudsen (1889) mentions that "... a third layer between these two strata which, as a transitional link between the two others, has a temperature and salinity which is increasing rapidly with depth ...". Here we find the basic concept of the thermocline as a transition zone in which the thermal gradient is greater than anywhere else in the column of water.

These two ideas were to be summarily and at times partly repeated (Murray and Hjort, 1912; Bjerkan, 1919; Sandstrom, 1919) then, gradually, increasingly greater importance was attached to the dynamics of the ocean (Munk and Anderson, 1948; Proudman, 1953; Robinson and Stommel, 1959; Welander, 1971; Lineykin, 1974). This zone of dynamic contrast therefore has been and will continue to be the subject of intense efforts at obtaining a better knowledge and understanding of the mechanism.

At the same time, the ecological importance of this thermal stratification did not escape researchers (Birge, 1897; Brandhorst, 1958; Jean, 1964; Vincent and Kurc, 1969; Rheinheimer, 1972; Garcia, 1974). It was probably because of the possible consequences of this that simplification was attempted of the application of the concept as initially experssed by Knudsen (1899). Thus what was selected was only the depth of the maximum gradient or else only the interval within which the gradient was greater than a threshold value, generally 1°C/m (Brönsted and Wesenberg-Lund, 1911; Birgay and Juday, 1914; Lacroix, 1961, 1967).

These practices continue but from the dynamics we have been able to understand, at least partly, that the many irregularities in the marine thermal stratification are part of a whole; this immediately draws our attention back to the concept of <u>zone</u> rather than <u>value</u> (Kitaygorodskiy and Filyushkin, 1963; Pickard, 1964).

Consequently, the description of the variable, complex reality represented by thermal, haline or other seasonal stratification gains by being approached from a point of view that is both descriptive and structural. (Tully and Giovando, 1963; Boudreault and Laprise, 1973).

The statistical analysis of this description can thus be made from the point of view of its own space-time variations (Boudreault, 1973) and of its relationship to primary productivity (Voituriez and Dandonneau, 1974; Herbland and Pages, 1975).

It is with this aim of producing an objective description of the seasonal thermocline and its subsequent analysis that we have developed the applications software (Boudreault, 1977).

2. OBJECTIVE

The primary objective of this report is the description of the applications software for the objective description of the thermocline and the way it functions. Also, we give some illustrations of possible analyses, made on the basis of this objective description.

With this software the thermal structures can be described and the pertinent parameters stored in an easily accessible file.

The modular assembly of this software (fig 1) will facilitate especially the modifications required for access to different types of variations (e.g., XBT, STD) or for the production of new forms of outputs.

This program and its subprograms are kept in a program library and are combined by the management system (UPDATE) specific to the CYBER-74[1] computer (cf Appendix I). To benefit fully from the modular nature of the applications software, it is better to be familiar with the use of the management system.

In this report we give also some examples of analyses that would normally be conducted under the responsibility of the actual user (fig 1).

3. DESCRIPTION OF THE APPLICATIONS SOFTWARE

3.1 Main Program THERMOB

3.1.1 Objective

This program (fig 2 and Appendix II) controls the execution of the

[1] CYBER-74 is manufactured by CONTROL DATA CORPORATION.

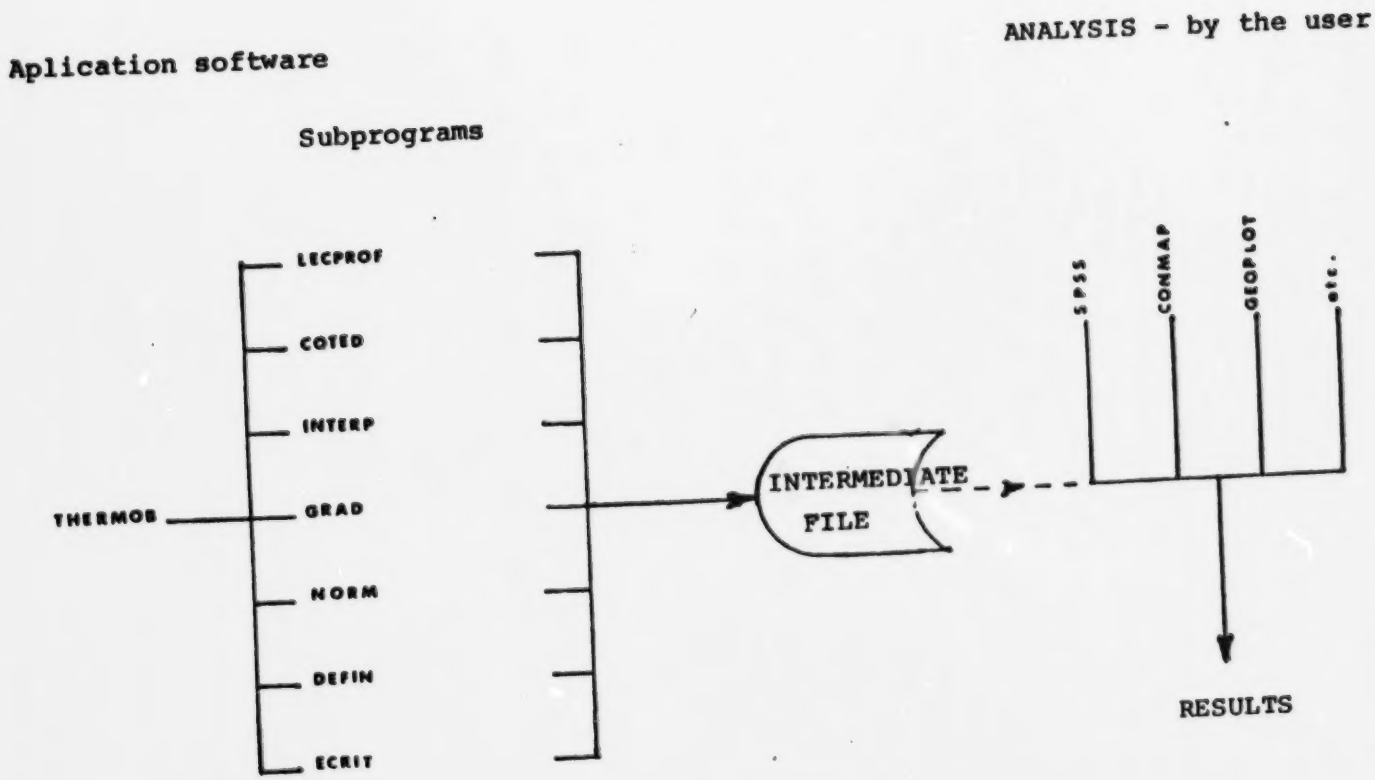


Figure 1 - Applications Software THERMOB

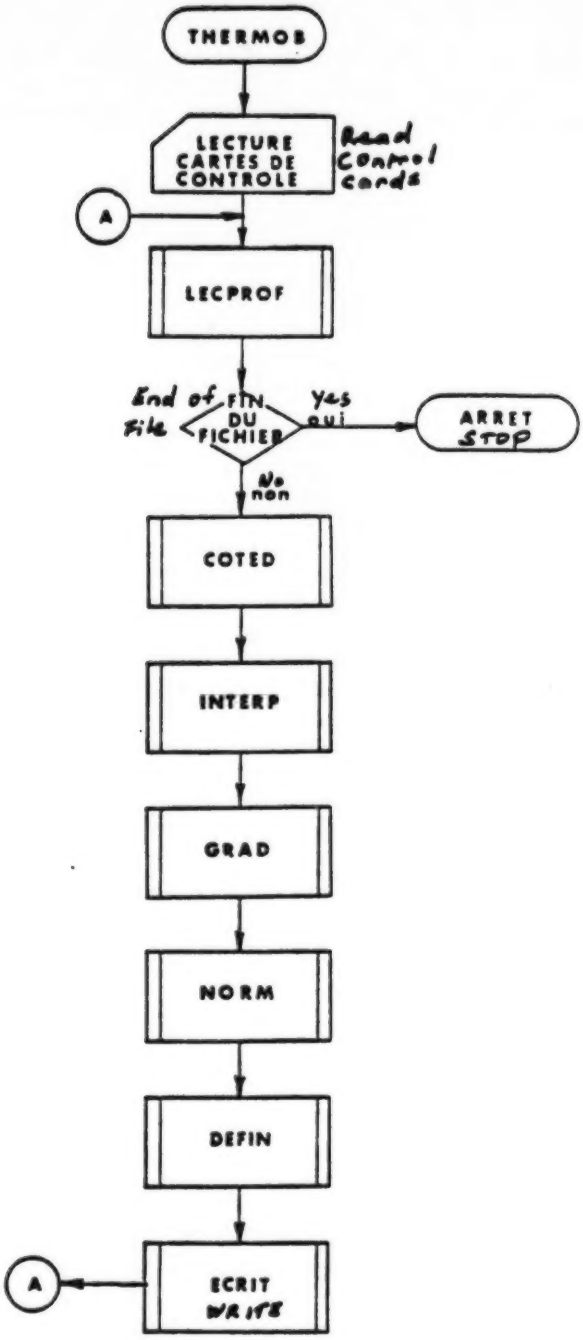


Figure 2 - Main Program THERMOB

various subprograms according to the instructions in the control cards.

3.1.2 Variations

Following the introduction of new subprograms, it will be necessary to revalidate THERMOB to ensure that it still serves the intended aim. For this, it is necessary to standardize the subprogram call names and the number of variables exchanged between the main program and each of these subprograms.

It must also be expected that some of the subprograms cannot be integrated into the present general program. For example, if we wanted to process a number of variables (e.g., T, S, P, N) at the same time, we would have to rewrite THERMOB.

3.1.3 Description of the Control Parameters

To meet the needs and desires of the users, we require control parameters for generating the description of the characteristics of each profile. These parameters are introduced on two punchcards (Appendix III), the first containing in order the following interpolation parameters:

(i) DINTER: Interpolation increment

(ii) DBINTER: Depth at which the interpolation will begin

(iii) FINTER: Depth at which the interpolation will end

All these values are recorded in whole decimetres (e.g., 12.5 m is written 125).

The second card contains the parameters for the calculation and normalization of the gradients:

(i) IOPT1 Normalization using the algebraic mean of the gradients (0 = no, 1 = yes)

(ii) IOPT2 Normalization using the mean of the absolute values of the gradients (0 = no, 1 = yes)

(iii) IOPT3 Normalization using the standard deviation of the gradients (0 = no, 1 = yes)

(iv) MINORM Minimum absolute value of a gradient that has a physical meaning (depends on the recording method; e.g., -0.40°C/m is written 4)

(v) RMIN Maximum normalized value defining a thermocline (e.g., -1.00 is written -100)

(vi) RMAX Minimum normalized value defining an inversion[1] (e.g., 1.00 is written 100)

---

[1] In the text and in the programs and subprograms, thermocline means a stratification with a negative gradient and inversion means a stratification with a positive gradient.

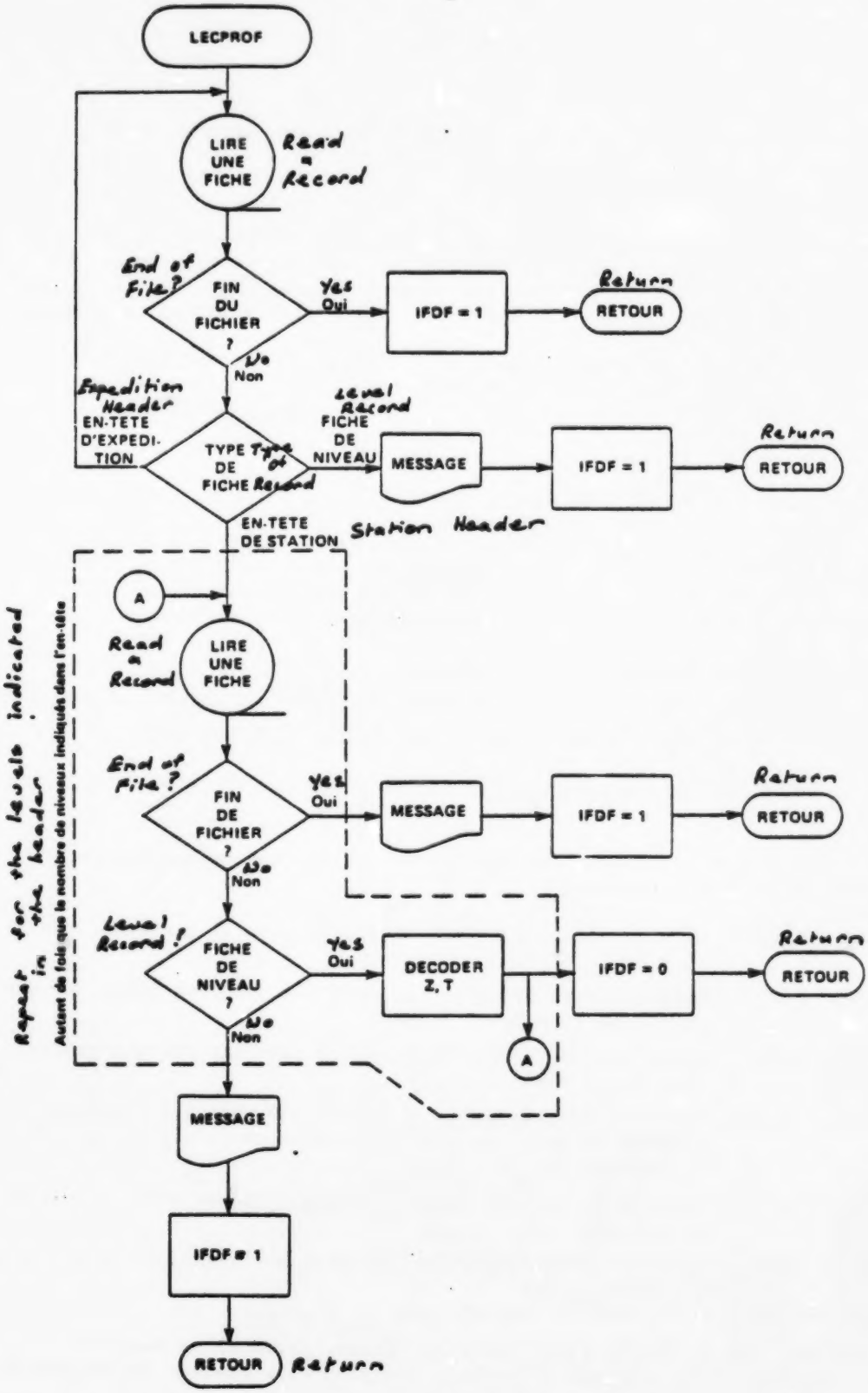


Figure 3 - Input Subprogram LECPROF

None of these parameters being implicit, these cards are essential for execution.

3.2 Input Subprogram LECPROF

3.2.1 Objective

This subprogram (fig 3 and Appendix IV) reads a profile coming from the BT data bank of MEDS[1]; this bank has a sequential form (Sweers, 1970a, p. 121). Only the header, depth and temperature fields are read, the others being ignored.

3.2.2 Variations

The BT data will from now on be part of a data base managed by the SYSTEM 2000[2], and access will thus be easier and quicker. Consequently, access to data stocked in this way will have to be through a new input subprogram which will require the FORTRAN PLI[3] of SYSTEM 2000.

Since we expect to have available thermal profiles obtained by instruments other than the BT's, it will be necessary to write other versions of LECPROF adapted to the format of each of these data sources. Also, if a user is interested in studying structures of variables other than temperature, it will be necessary to make the pertinent changes so as to have access to these variables.

3.3 Subprogram for Computing the COTED Square: COTED

This subprogram generates a code to define uniquely a square with 10° sides (Sweers, 1970).

An extension of the system to define a region with 1° sides is possible, and figure 4 gives the procedure to obtain it. We will use this method.

3.4 Interpolation Subprogram INTERP

3.4.1 Objective

In order to define the thermal structure, each profile must be divided into constant depth intervals (Boudreault and Laprise, 1973); the gradients calculated cannot therefore tend to infinity. According to the

---

[1] MEDS: Marine Environmental Data Services Branch

[2] Data management software sold by MRI Corporation (Austin, Texas)

[3] Procedural Language Interface

Y = Yes N = No

Is latitude North Is longitude West	Y Y	Y N	N Y	N N
X = Latitude + 90	X	X		
X = 90 - Latitude			X	X
Y = Longitude	X		X	
Y = 360 - Longitude		X		X
NN = X/10	X	X	X	X
D_N = X - NN x 10	X	X	X	X
WW = Y/10	X	X	X	X
D_W = Y - WW x 10	X	X	X	X
COTED Square = $NNWWD_ND_W$	X	X	X	X

Figure 4 - Decision Table to Calculate the COTED Square

method of data gathering and reduction, the interpolation technique could be different. For data used until now, meaning the bathythermographic data processed and stored at the MEDS, a linear interpolation (Yergen, 1969) will do for recreating the original values to ±0.05°C.

3.4.2 Description of the Subprogram

The user must define the depth interval (DINTER) and the depths at which interpolation will begin (BGINTER) and finish (FINTER) (fig 5 and Appendix V).

The number of levels the profile has at input is passed to this subprogram by LECPROF (variable NIVEAUX).

The output of this subprogram consists of all the depth temperature pairs (Z(I), T(I)) interpolated.

3.4.3 Possible Variations

Some data do not lend themselves to linear interpolation because of the gathering method. Classical hydrology observations taken at levels chosen subjectively by the researcher are an illustration of this.

Despite the inaccuracies associated with such discontinuous measurements (Rattray, 1962), it is possible to think of an appropriate interpolation (Reiniger and Ross, 1968).

We would therefore use one or more non-linear interpolation subprograms for making this kind of analysis of the thermal structure.

3.5 Subprogram for Computing the Gradients GRAD

This subprogram (Appendix VI) computes the thermal gradient in each depth interval and for the whole profile the mean gradient, the mean of the absolute values of the gradients and the standard deviation of the gradients. If other types of means are needed in the future, this subprogram can easily be modified.

3.6 Normalization Subprogram NORM

This subprogram (Appendix VII) normalizes the thermal gradient values by use of the appropriate mean for the option decided on (cf the control card for calculating gradients, Appendix III).

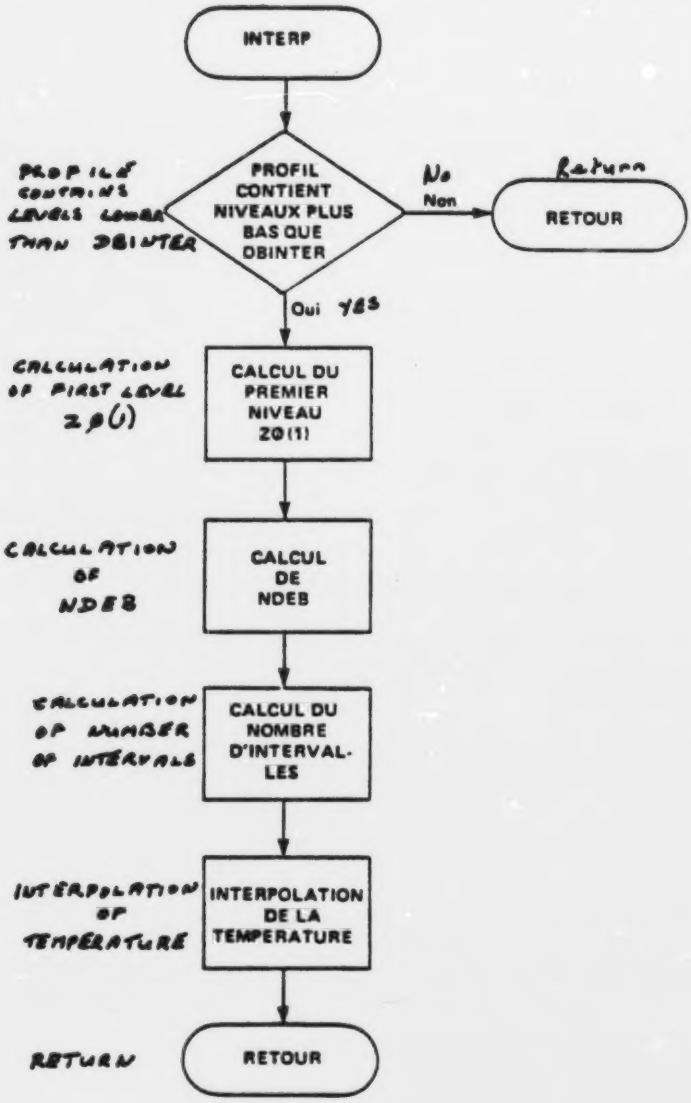


Figure 5 - Interpolation Subprogram INTERP

3.7 Diagnosis Subprogram DEFIN

3.7.1 Objective

Once the gradients are calculated and normalized, the problem is to detect the presence of structures (thermocline, inversion) and to describe their characteristics: the depth where they begin, thickness, temperature at the beginning of the structure, and the series of gradient values and normalized gradients.

3.7.2 Description of the Software

The structures are defined through the use of two control values, RMIN and RMAX, determined by the user (fig 6 and Appendix VIII). The first is the maximum algebraic value at which a normalized gradient is part of a thermocline, and the second is the minimum algebraic value of the normalized gradient defining an inversion.

We therefore need to compare each of the normalized gradients of a profile with these two values and thus determine the type of structure to which the depth interval belongs. We will thus obtain the description of the structures (beginning depth, thickness, and so on).

3.7.3 Examples of Structure Definition

Figs 7 and 8 illustrate the diagnosis generated by DEFIN for some profiles. The profiles obtained from the BT file are drawn and the interpolated values superimposed in the form of triangles. The gradient for each interval is printed out as is the diagnosis for each of the options. Above the title MEANS we give the mean gradient under the diagnosis of option 1, the mean of the absolute values under option 2, and the standard deviation of the gradients under option 3.

Intervals belonging to a thermocline are indicated by a minus sign, those belonging to an inversion by a plus sign; and 0 indicates an interval where the gradient is small, i.e., greater than RMIN and smaller than RMAX. In these examples, RMIN was equal to -1.0 and RMAX equal to 1.0. Where the diagnosis was not printed out, the mean was lower in absolute value than DIVMIN, the resolution threshold of the system (in this case 0.04°C/m).

3.8 Output Subprogram ECRIT

3.8.1 Objective

Once the description of the profiles is finished, it is necessary to establish an intermediate file containing all the information required for a

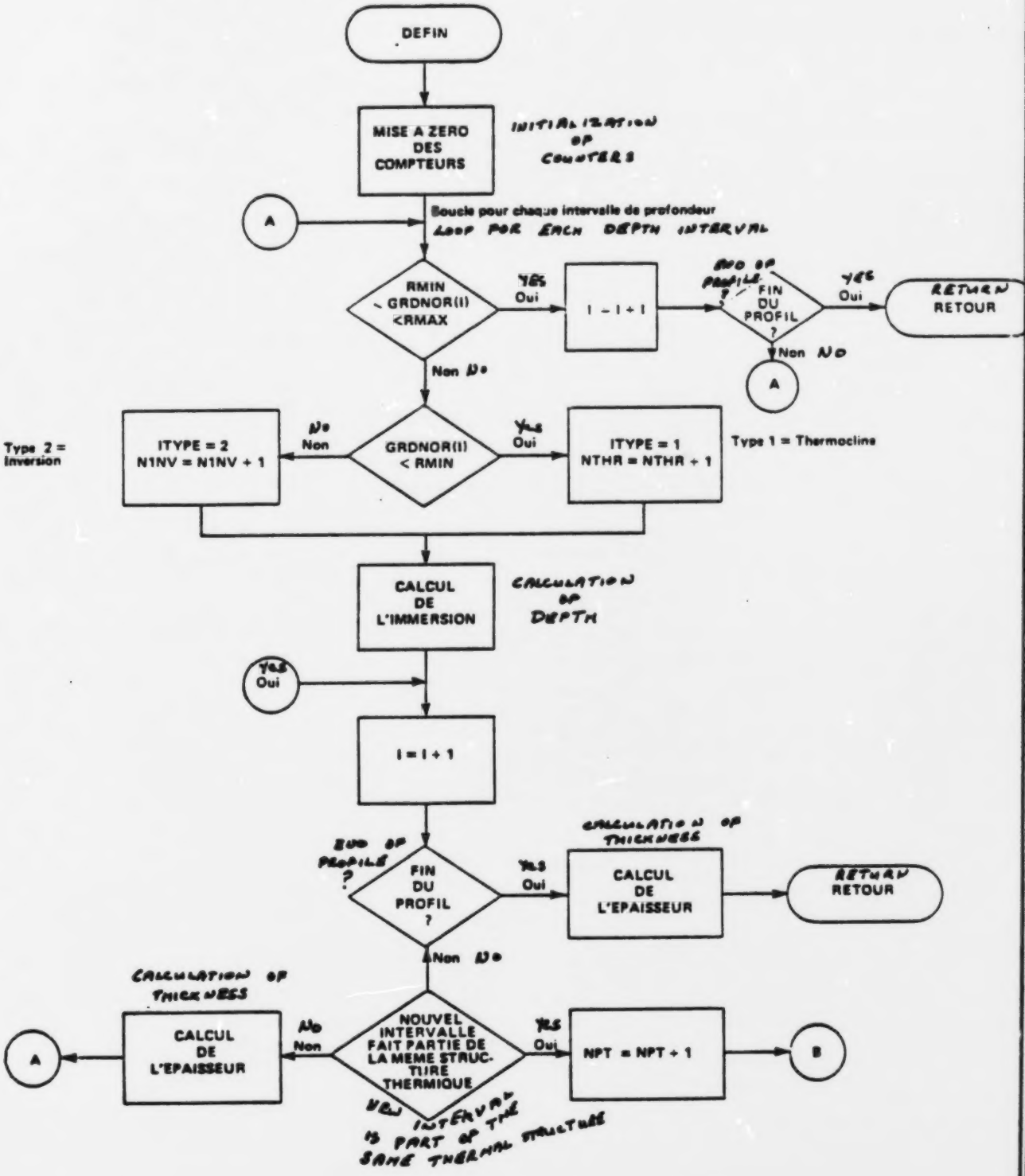


Figure 6 - Diagnosis Subprogram DEFIN

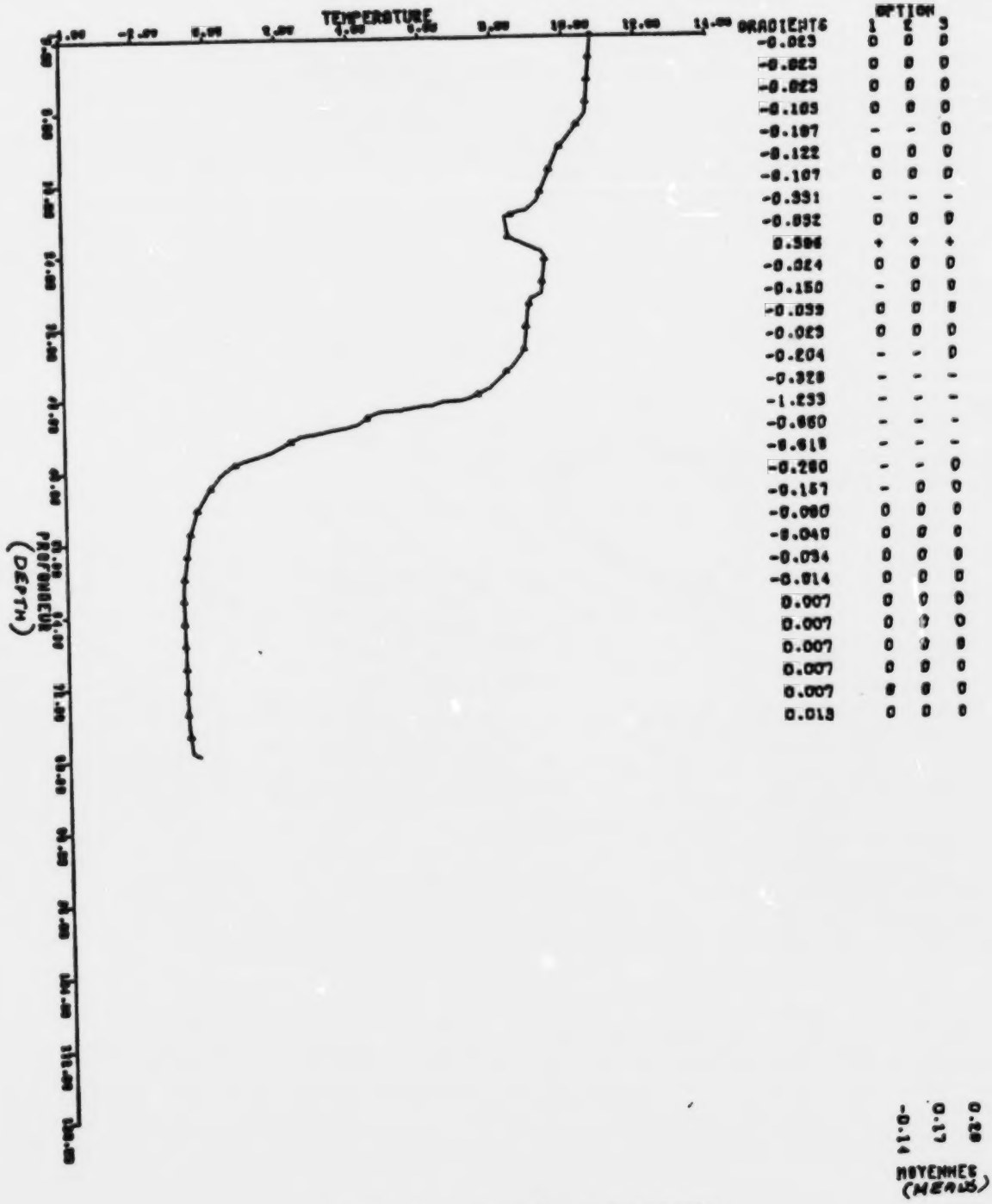
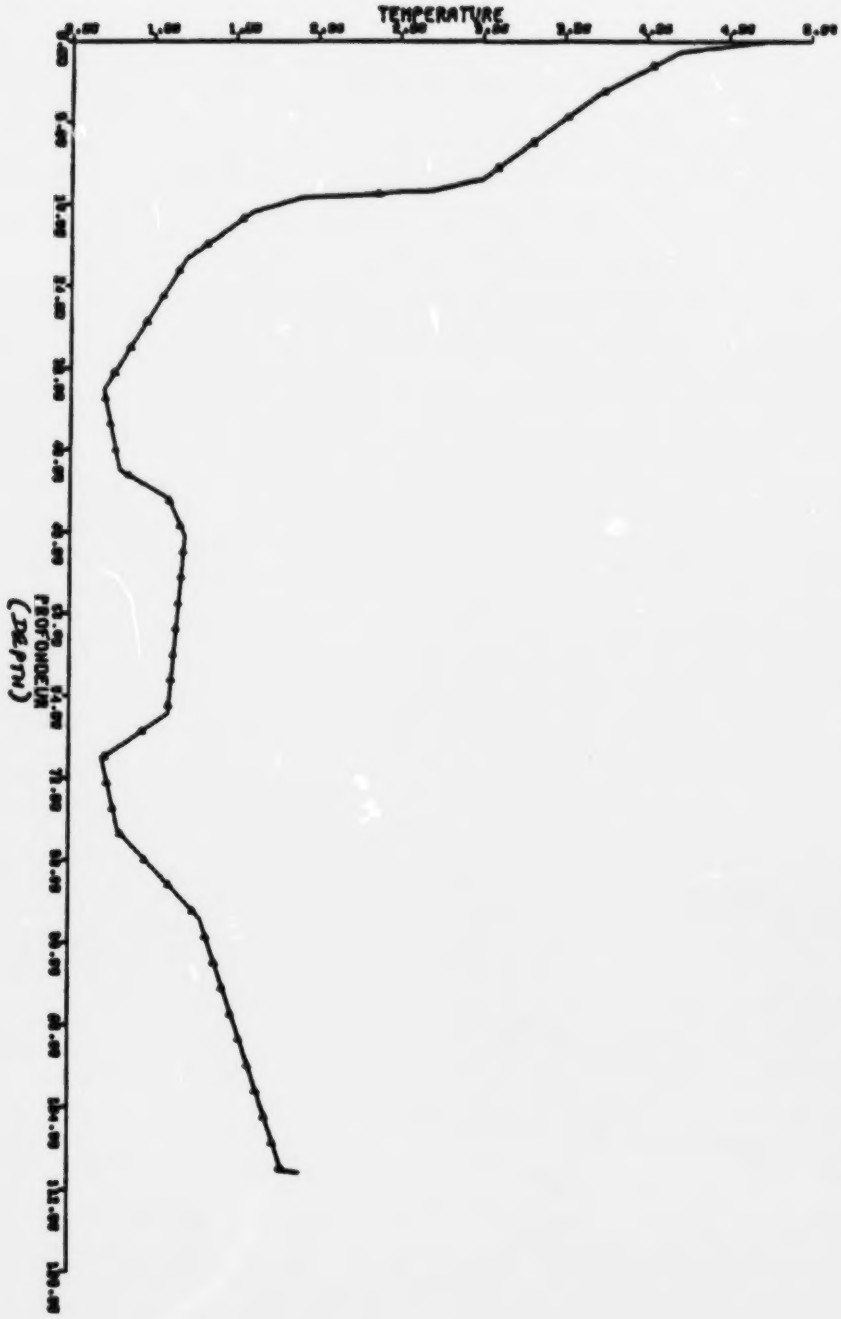


Figure 7 - Example of Diagnosis



GRADIENTS	1	2	3
-0.119		-	-
-0.069		-	-
-0.064		-	-
-0.084		-	-
-0.290		-	-
-0.329		-	-
-0.069		-	-
-0.067		-	0
-0.038		0	0
-0.039		0	0
-0.035		0	0
-0.039		0	0
-0.022		0	0
0.013		0	0
0.013		0	0
0.032		0	0
0.101		+	+
0.027		0	0
0.007		0	0
-0.006		0	0
-0.006		0	0
-0.006		0	0
-0.006		0	0
-0.006		0	0
-0.006		0	0
-0.064		-	0
-0.091		-	-
0.006		0	0
0.014		0	0
0.020		0	0
0.059		+	0
0.059		+	0
0.059		+	0
0.091		0	0
0.020		0	0
0.020		0	0
0.020		0	0
0.020		0	0
0.020		0	0
0.020		0	0
0.020		0	0
0.020		0	0
0.020		0	0
		0.04	0.00

MOYENNES (MEANS)

Figure 8 - Example of Diagnosis

later analysis (Appendix IX). The structure of this file represents the balance point between the amount of information that can be extracted directly and the amount of storage space that can be saved. The file meets the needs expected at the time it was set up but is certainly not the only way of storing the description of the profiles, or the better way, since that is directly related to the use you want to make of the file.

3.8.2 Description of the File

The file is currently recorded on magnetic tape sequentially by month and by COTED square within each month. It is composed of two types of logical records: the header record, and the structure record.

3.8.2.1 Header

The header record contains general information about a profile: identification, position, date and hour, weather conditions, interpolation conditions, mean of the gradients according to the option and number of thermoclines and inversions, in the format described in fig 9.

3.8.2.2 Thermal Structures

Each of the header records is followed by a number of structure records, each containing the information related to a particular thermal structure (thermocline or inversion) (fig 10); of course, if the mean gradient is less than the system's resolution threshold (DIVMIN), there will be no structure record.

3.8.3 Other Forms of Intermediate File

Although the present form of the file meets the expected needs, certain disadvantages of this type of file are beginning to appear. The biggest of these is the size. This is evident when a statistical analysis of the information in the header is to be made, since it is necessary to read all the details of the structures in order to find the correct position on the magnetic tape.

One possible solution is to have two files: one containing the headers, the other containing the details of the structures. This solution has the advantage of providing rapid access to the information. On the other hand, the updating programs are more complicated.

Another solution is to have a random access file managed by a system like SYSTEM 2000. Access to such a system is rapid and, in addition, it is possible for non-computer personnel to extract the information without formal recourse to software.

Order	Field	Format	Description
1	ICRN	I9	Cruise number
2	ISTN	I3	Station number
3	LAH	A1	Latitude hemisphere
4	LAT	I6	Latitude DDMM.MM
5	LOH	A1	Longitude hemisphere
6	LON	I7	Longitude DDDMM.MM
7	IAN	I2	Year
8	MOIS	I2	Month
9	JOUR	I2	Day
10	IHEURE	I4	Time U.T. (HHMM)
11	NIVEAUX	I2	Number of levels in the profile
12	CARRE MARSDEN	I3	10° Square identification
13	ISONDE	I5	Bottom depth in 0.1 m
14	Libre	5X	Free
15	NEBULOSITE	I1	Cloud amount in octants
16	DIR. VENT	I2	Wind direction in 10°
17	VIT. VENT	I2	Wind speed
18	Code WW	I2	Weather code
19	PRESS	I3	Atmospheric pressure in 0.1 dbar with hundreds removed (i.e., 965.5 dbar is coded 655)
20	TEMPAIR	I3	Air temperature in 0.1°
21	TEMPHM	I3	Wet Bulb temperature in 0.1°
22	PDVAG	I2	Wave period in seconds
23	HTVAG	I2	Wave height in multiples of 0.5 m
24	DIRHL	I2	Swell direction in 10°
25	PERHL	I2	Swell period in seconds
26	HTHL	I2	Swell height in multiples of 0.5 m
27	CLASSE	I1	Classification
28	ITYP	I1	Record type in OCEANS V
29	ICOTED	I6	Coted Square
30	INTER	I4	Interpolation interval in decimetres
31	IDB	I5	Interpolation starting depth in decimetres
32	IFIN	I5	Interpolation ending depth in decimetres
33	NDEB	I2	Order of first interpolated interval
34	IOPT	I1	Normalization option
35	MOY	I5	Average (according to option) in .01°C/m
36	INDIC	I1	Indication of normalization
37	MIN	I4	Maximum normalized gradient indicating a thermocline (-1.0 will be coded as -100)
38	MAX	I4	Minimum normalized gradient indicating an inversion (1.0 will be coded as 100)
39	NTHR	I3	Number of thermoclines
40	NINV	I3	Number of inversions

Figure 9 - Format of the Header Record

Field	Format	Description
ICRN	I9	Cruise number
ISTN	I3	Station number
ITYPE	I1	Type of structure (1 = thermocline; 2 = inversion)
IORDRE	I2	Sequence number for type of structure
IZDEB	I6	Depth of beginning in decimetres
NPOINT	I3	Number of intervals in the structure
IEPAIS	I5	Thickness in decimetres
ITEMP	I5	Temperature at beginning in 0.001°C
IGRS(1)	I5	Gradient in 0.01°C/m
IGRS(NPOINT)		
IGRSNOR(1)	I5	Normalized gradient in 0.01
IGRSNOR(NPOINT)		

Figure 10 - Format of Structure Record

Although it is more difficult to establish such a file than it is for a sequential file, the updating is simplified.

4. SOME POSSIBLE ANALYSES

4.1 Printout of the Intermediate File

For the purpose of visual verification of the data or manual processing of a small part of the data, it is often very useful to print out the information contained in the intermediate file clearly and legibly for the uninitiated (i.e., anyone who cannot read a dump). This type of printing is necessary also for discovering illogical values or errors in the header. Fig 11 gives an example of this kind of printout to illustrate the possibilities.

4.2 Printout of Diagnosis

In order to make a quick initial analysis of the diagnosis or to detect subjects that are worthy of further analysis, a printout of the diagnosis can be made in symbolic form, as shown in fig 12.

4.3 Geographic Distribution of a Variable

Fig 13 shows the spatial distribution of the thickness of the first thermocline in the northwest section of the Gulf of St. Lawrence during a cruise in August 1974 (CRN 180674002). The contours were drawn by means of the CONMAP program (Taylor, 1976).

4.4 Statistical Distribution

Fig 14 shows the probability distribution of the mean intensity of a thermocline and the depth of its beginning for August and October 1973 at Station "P" (45°N, 150°W).

This kind of presentation (Taylor et al., 1971) makes it possible to situate quickly the typical values for the immersion-intensity pair of the thermocline for this region and this time. Other pairs of variables, like thickness and immersion of the thermocline, could, of course, be studied. A comparative study of the months would give us the changes in the relation between the two variables over time.

4.5 Time Distribution

Fig 15 shows the depth and thickness of the thermocline at Station "P" (45°N, 150°W) for 1973. (See a similar illustration for 1956 at Station "P" in Tully and Giovando, 1963, p. 31.) This type of illustration permits an examination of the changes in the seasonal thermocline over time and the detection of the presence of multiple thermoclines.

```
1015730052141 1   165 10  2501026a     **  *10  *26  *15  *22   *6   *5   *5  *11  *10 *104 *259 *444 *375 *561 *158 *124 *124 *283
                                                  *252
1015730052141 2   985  5  125 7695     **   **   **   **   ** *120 *120 *120 *120 *112
1015730052141 3   800  *  100 6*27     **   **   **   ** *150 *150 *150 *120

1015730052141*995000=1**53.073 7*0 3.0021159000030          000                  2131*9*  25    0 1500 22    *1 *10  10  2  0
1015730052141 1   265 11  275102*1     *5  *17  *17   *8   *8   *8   *8   *7  *12  *10   *7 *126 **32 **32 *200 *200 *200 *198 *187
                                                  *494 *255 *175
1015730052141 2   675  9  225 7.19     *5   *7   *7   *7   *5   *5   *5   *5   ** *130 *182 *182 *182 *128 *124 *124 *124 *10*

1015730052141*A5L0830=1**56.073 7*0 6.0018195000030          000                  21*1*0*  25    0 1500 12    *1 *10  10  3  0
1015730052141 1   190  8  2501C7*7     **   **  *22  *1*  *1*  *13  *12   *5 *11* *11* *562 *371 *371 *329 *309 *141
1015730052141 2   *25  3   75 8.1*     **   **   ** *109 *161 *115
1015730052141 3   700 13  325 7322     **   **   **   **   **   **   *8   *7   **   **   **   **   ** *11* *152 *152 *152 *152 *152
                                                  *402 *17* *107 *107 *107 *107 *107

1015730052191*995000=1**58.073 7*0 9.0018195000030          000                  2131*9*  25    0 1500 12    *1 *10  10  2  0
1015730052191 1   190 12  3001C**1     *9  *12  *15  *13  *11   *9   *6   *6   *7   *7   *7   ** *2*2 *318 *391 *345 *292 *228 *170
                                                  *170 *161 *188 *188 *112
1015730052191 2   *00  4  200 6*1*     *5   *5   *5   *5   *5   *5   *5   *5 *132 *145 *145 *145 *145 *151 *165 *165

1015730052191*995000=1**58.073 7*01210*0195000000           000                  2131*9*  25    0 1500 12    30 *10  10  0  0

1015730052171*995000=1**53.073 7*0150*2195000000            000                  2131*9*  25    0 1500 12    *1 *10  10  2  0
1015730052171 1   190 10  *0010*11     *8  *25  *13   *6  *10   *8   *7   *7   *7   *7   *7   *7   *7   *7   *5   ** *131 *408 *325
                                                  *149 *257 *200 *168 *168 *168 *168 *168 *168 *168 *168 *124 *10*
1015730052171 2   700  *  100 710*     **   *7   *9   *9 *159 *17* *218 *227

1015730052191*5002.0=1*5300.073 7*018.0171950000000         000                  21*1*0*  25    0 1500 12    30 *10  10  0  0

1015730052191*995000=1**58.073 7*021.0021950000000          000                  2131*9*  25    0 1500 12    30 *10  10  0  0

1015730052*0*8000.0=1*5300.073 7*1   0171950000000          000                  21*1*0*  25    0 1500 12    *1 *10  10  2  0
1015730052*01 1   150 15  375109*4     **   *8  *20  *15  *1*   *7   *5   *5   *5   *5   *5   *5   *5   ** *158 *218 *510 *392
                                                  *4*3 *172 *140 *140 *140 *140 *140 *140 *140 *140 *107
1015730052*01 2   750  6  150 6*12     **   *5   *6   *8   *8   ** *155 *163 *163 *207 *209 *109

1015730052*01*5.000.0=1**58.073 7*1 3.0019150000000         000                  21*1*0*  25    0 1500 12    30 *10  10  0  0

1015730052*9*995000=1**57.073 7*1 6.0017150000000           000                  2131*9*  25    0 1500 12    30 *10  10  0  0

1015730052*9*995000=1**53.073 7*1 9.0011150000000           000                  2131*9*  25    0 1500 12    *1 *10  10  2  0
1015730052*01 1   75 1*  *5010.02     *5  *23  *12  *10   *7   *7  *11  *12   *7   *5   **   **   **   ** *22* *897 *303 *254 *194
                                                  *194 *291 *309 *17* *159 *100 *100 *100 *100
1015730052*01 2   700  9  225 6*1*     **   *8   *8   *5   **   **   **   **   ** *119 *211 *211 *148 *113 *113 *113 *113 *107

1015730052*9*995000=1**52.073 7*112.0018150000000           000                  2131*9*  25    0 1500 12    30 *10  10  0  0

1015730052*9*995*00=1*503.073 7*11*0*0215900000             000                  2131*9*  25    0 1500 12    30 *10  10  0  0

1015730052*9*995000=1**57.073 7211*.0019150000000           000                  2131*9*  25    0 1500 12    30 *10  10  0  0

1015730052*7*995000=1**55.073 7212100021500000              000                  2131*9*  25    0 1500 12    *1 *10  10  2  0
1015730052*71 1   125 11  275107*1     *5  *1*  *1*   *7   *7  *15  *11   *9  *13  *13   *5 *134 *352 *367 *191 *191 *394 *268 *225
                                                  *223 *325 *184
1015730052*71 2   650 16  *00 7421     **   *5   *5   *5   *5   *5   **   **   **   **   **   **   **   ** *114 *155 *155
                                                  *155 *155 *129 *101 *101 *101 *101 *101 *101 *101 *101 *101 *101
```

Figure 11 - Printout of the Intermediate File

```
(MONTH)
   MOIS=  6        CRITE= 1.1494
181573005310   1   00000000--------000000000000000000----------000000000000000000
181573005313   1   000000000---0-----00000000---------000000000000000000000000000
181573005316   2   --000000---------000000000000------000000000000000000000000000
181573005319   2   00000000---------00000000-----00000--00000000000000000000000000
181573005322   2   00000000---------00000000---------000000000000000000000000000
181573005324   3   -000000---------000000---------000000000000000000000000000000
181573005327   3   00000000---------00000000000---------------000000000000000000
181573005328   4   000000000000---------00000---------000000000000000000000000000
181573005330   3   00000000000000----------000000000000----------00000000000000000
181573005331   4   000000000000---------000000000---------00000000000000000000000
181573005332   4   00000000000---------00000000--------000000000000000000000000
181573005333   4   000000000000---------00000000---------00000000000000000000000
181573005334   4   00000000000---------000000000----------000000000000000000000
181573005335   4   00000000--------000000000000000000000000--------000000000000
181573005336   4   00000000000--------000000000000000000--------00000000000000000
181573005339   5   00000000000---------00000000-----00000-000000000000000000000
181573005340   5   00000000000---------000000000000000----------000000000000000
181573005341   5   00000000000000------00000000----------000000000000000000000
181573005342   5   00000000----------00000000----------000000000000000000000
181573005343   5   00000000-----000000000000000----------000000000000000000000
181573005344   5   00000000000------000000000000---000000000000000000000000000
181573006 21   6   00000000----------000000000000000000--00000000000000000000
181573006 22   6   00000000000---------000000000000----000000000000000000000000
181573006 24   7   00000000----------000000000000000----------00000000000000000
181573006 28   7   00000000000000---------00000000------000000000000000000000000
181573006 44   9   00000000000000---------00000000----------00000000000000000000
181573006 45   9   00000000----------00000000000----------00000000000000000000
181573006 46   9   00000000000----------00000000000000---000000000000000000000
181573006 47   9    00000000000000----------00000000---00--000000000000000000000
181573006 51  10    00000000000----------000000000000000-----000000000000000000
181573006 53  10   00000000----------00000000000000---------000000000000000000
181573006 54  10   00000000000----------000000000000000---------000000000000000
181573006 56  11   00000000000---------00000000000---------000000000000000000000
181573006 58  11   00000000----------000000000000-0000------000000000000000000
181573006 59  11   00000000000--------000000000000000000000000000000000000000000
181573006 60  11   00000000000----------00000000000-000000------000000000000000
181573006 63  11   00000000----------00000000--------000000000000000000000000000
181573006 64  12   00000000000----------00000000000----------000000000000000000
181573006 66  12   00000000----------00000000----------00000000000000000000000
181573006 68  12   00000000000----------00000000000000000------000000000000000000
181573006 69  12   00000000----------00000000000000000-----000000000000000000000
181573006 70  12   00000000000---------000000000000000000000000000000000000000000
181573006 71  12   00000000000---------00000000000000000---000000000000000000000
181573006 73  13   00000000----------00000000--------000000000000000000000000000
181573006 74  13   00000000------000000000000000----------000000000000000000000
181573006 75  13   00000000000--------000000000000000000000---000000000000000000
181573006 76  13   000000000000--------00000000000000-----000000000000000000000
181573006 77  13   00000000000----------00000000000000000-000000000000000000000
181573006 78  13   00000000---------000000000000---000000000000000000000000000
181573006 79  13   00000000000----------00000000----00000000000000000-000000000
181573006 81  14   00000000---------000000000000000000000000000000000000000000
181573006 82  14   00000000000--------000000000000000000000000000000000000000000
181573006 83  14   00000000---------000000000000000000-----000000000000000000000
181573006 84  14    00000000000--------00000000000000----0000---000000000000000000
181573006 86  14    00000000--------000000000000-----000000000000000000000000000
181573006 87  14   00000000000------000000000000000000000000000---000000000000000
181573006 88  15   00000000000--------000000000000000---000000000000000000000000
181573006 89  15   00000000000--------000000000000000--0000---000000000000000000
181573006 90  15   00000000----------000000000000000------000000000000000000000
181573006 91  15   00000000000---------00000000000----------000000000000000000000
181573006 92  15   00000000000---------000000000000000000000000000000000000000000
```

Figure 12 - Printout of Diagnosis

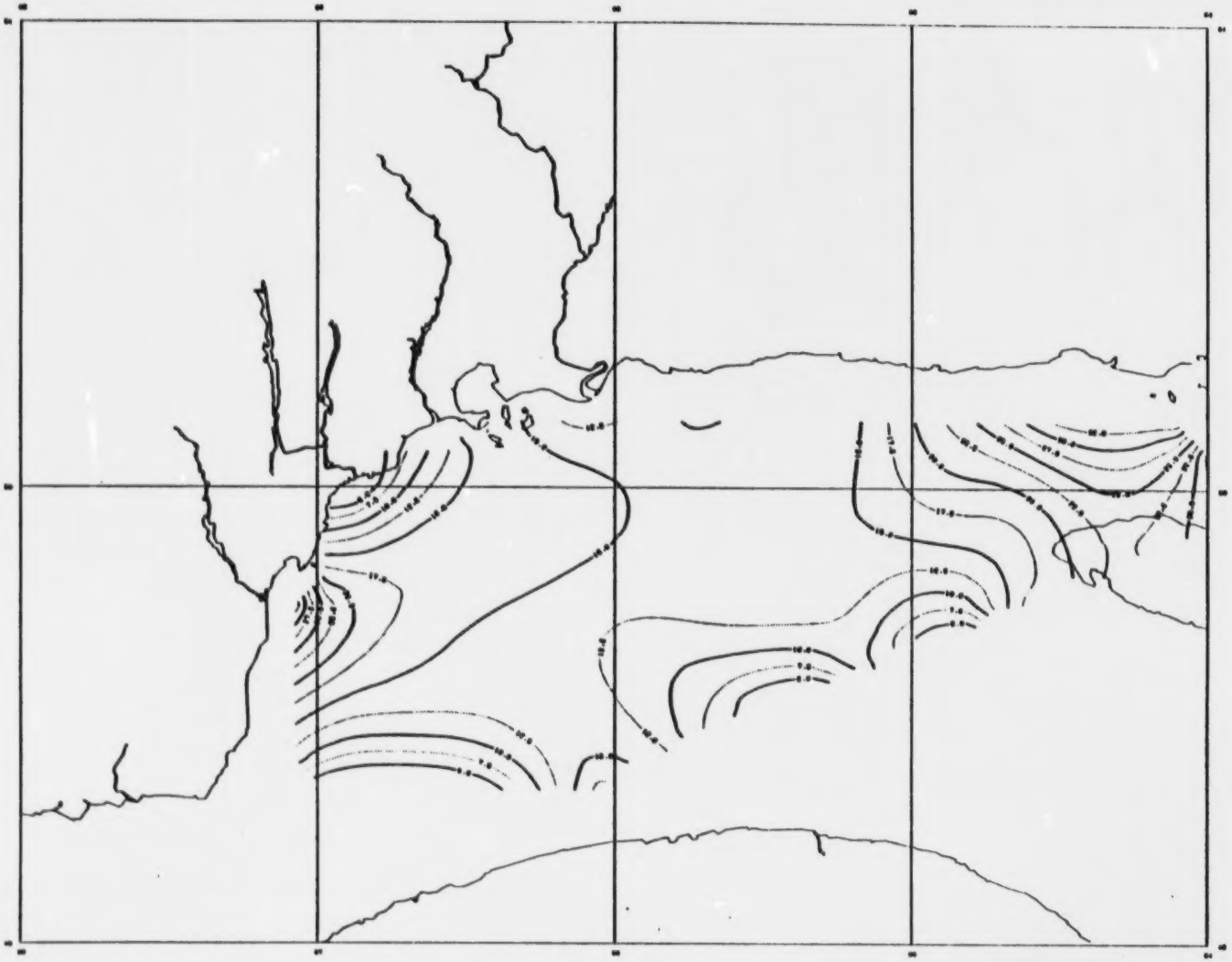


Figure 13 - Thickness of the First Thermocline in the Northwestern Gulf of Saint Lawrence (August 1974)

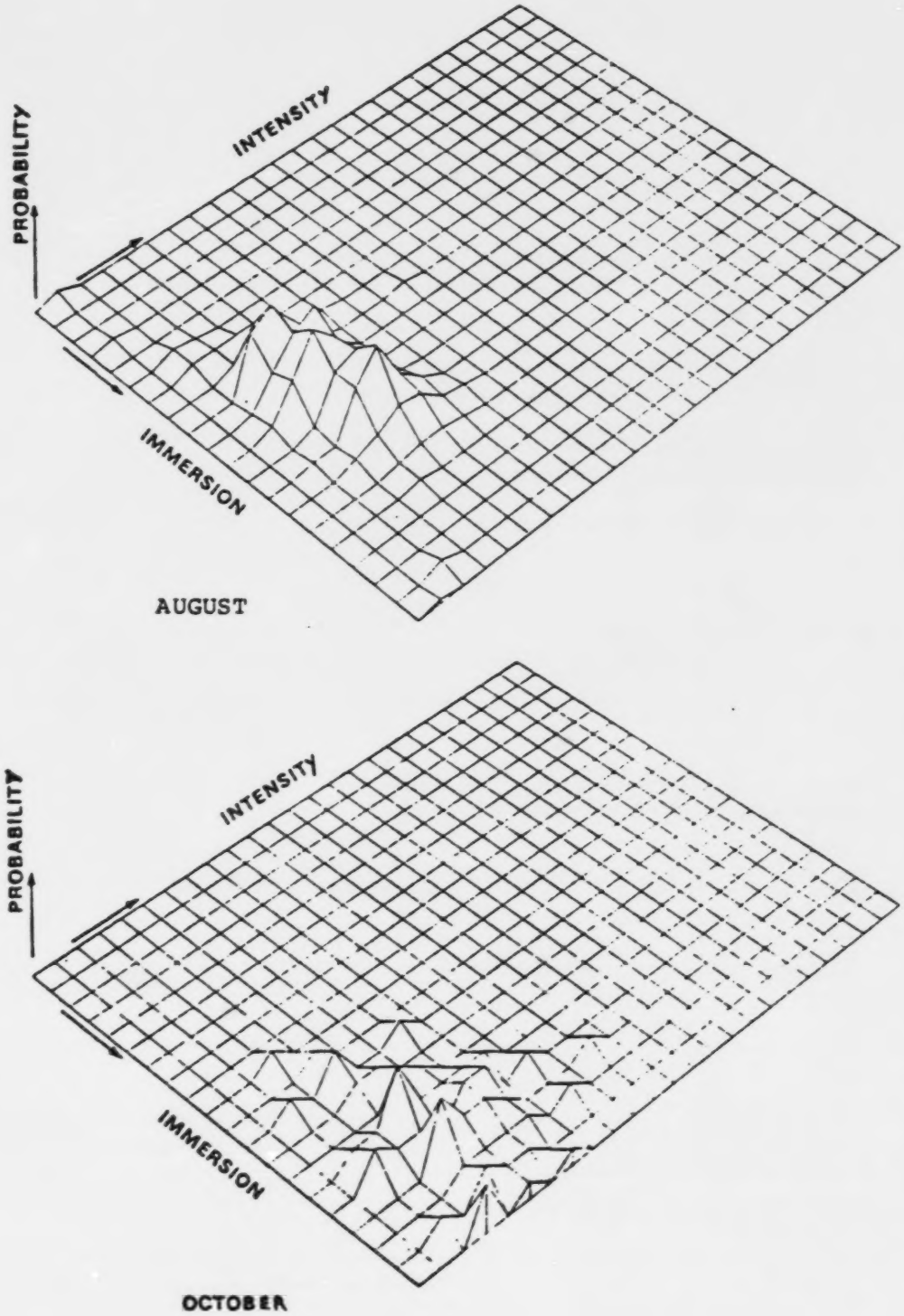


Figure 14 - Probability Distribution for the Mean Intensity of a Thermocline and of its Starting Depth for August and October 1973 at Station "P"

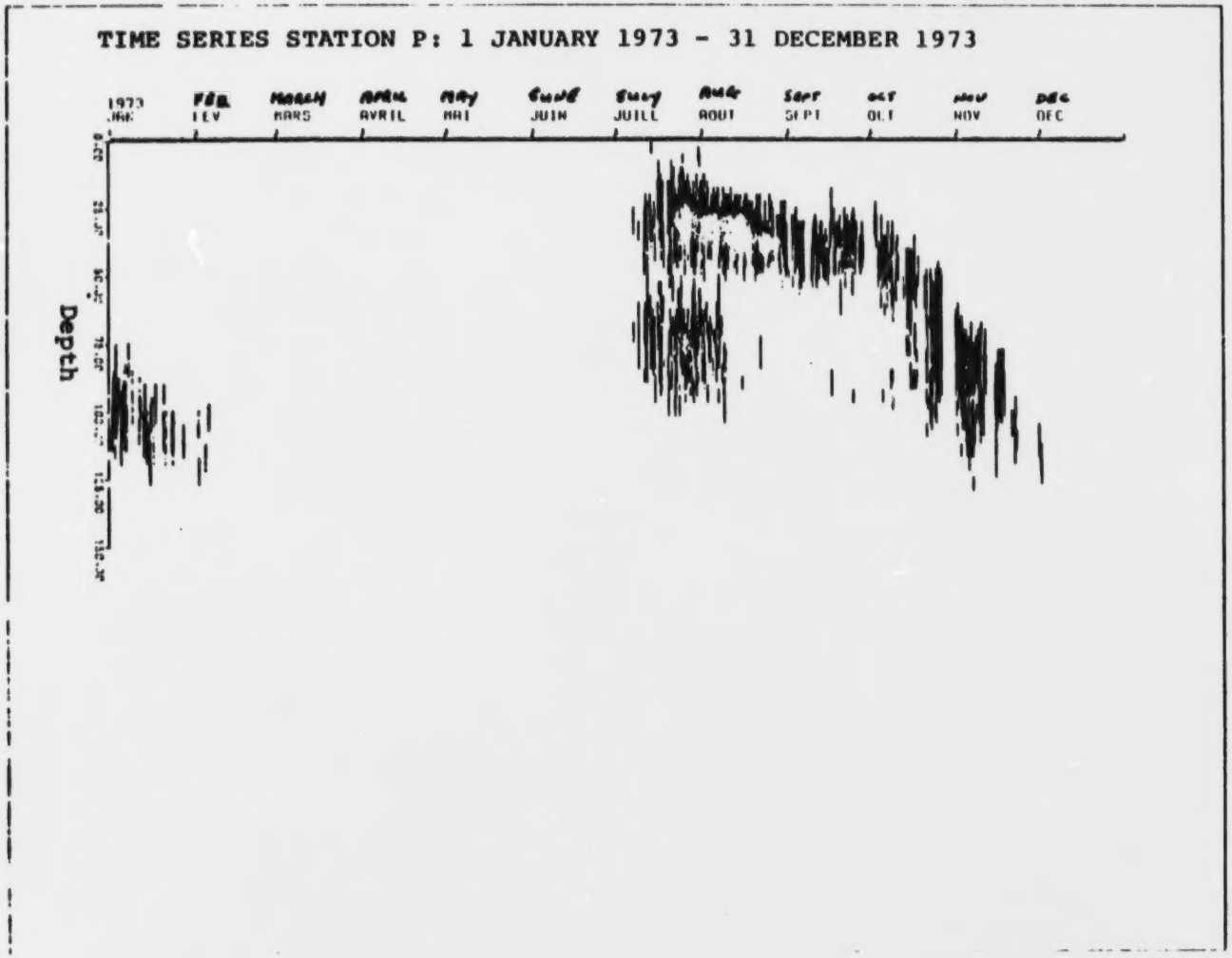


Figure 15 - Depth and Thickness of the Thermocline at Station "P" in 1973

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6. APPENDICES

Appendix I

```
UNLABELED BLOPL                CARDS ENCOUNTERED IN INPUT              UPDATE 1.2****.      28/04/79  09.39.02.
*****    *COMPILE DBLDIS

         MODIFICATIONS / CONTROL CARDS


              CORRECTION IDENTS ARE LISTED IN CHRONOLOGICAL ORDER OF INSERTION

         MAIN       LECPROF    COTED      INTERP     DEFIN      GRADIEN    NORMAL     ECRIT
         DEBMIST    SYMBOL     BALAYE     MERGER     DBLDIS     RAPSTRC    PROFPLOT   LISTE
         THERMULT   SELECT     DEBFIN     CHRONOPLT  TRACER     JN260978   JN280978   JN290978
         JN081178   JN111278   JN201278   JN281278   JN060178   JN0601791  JN160178

DECKS ARE LISTED IN THE ORDER OF THEIR OCCURRENCE ON A NEW PROGRAM LIBRARY IF ONE IS CREATED BY THIS UPDATE

         YANKEES    MAIN       LECPROF    COTED      INTERP     DEFIN      GRADIEN    NORMAL
         ECRIT      DEBMIST    SYMBOL     BALAYE     MERGER     DBLDIS     RAPSTRC    PROFPLOT
         LISTE      SELECT     THERMULT   TRACER     CHRONOPLT  DEBFIN

         DECKS WRITTEN TO COMPILE FILE

         DBLDIS

THIS UPDATE REQUIRED  34100B WORDS OF CORE.
```

Appendix II

```
74/74   OPT=1                                FTN 4.6+446        27/02/79  08.38.37

      PROGRAM THERMO2(INPUT,OUTPUT,TAPE1=INPUT,TAPE2=OUTPUT,TAPE3,TAPE4) MAIN
C                                                                       MAIN
C     PROGRAMME POUR DETERMINER L'EXISTENCE DE THERMOCLINES DANS UN PROF MAIN
C     CALCULE LA PROFONDEUR, EPAISSEUR ET INTENSITE                     MAIN
C     ENREGISTRE LES RESULTATS SUR UN FICHIER INTERMEDIAIRE POUR        MAIN
C     FINS D'ANALYSE SUBSEQUENTE                                        MAIN
C                                                                       MAIN
C     J. NASH,SDMM,FEVRIER 1976                                         MAIN
C                                                                       MAIN
C     DEFINITION DES NOMS DE VARIABLES                                  MAIN
C     INDAT   BLOC DES DONNEES DU PROFIL DANS OCEANS                    MAIN
C        Z   PROFONDEUR                                                 MAIN
C        T   TEMPERATURE                                                MAIN
C     INTDAT   BLOC DES DONNEES INTERPOLEES                             MAIN
C        TO   TEMPERATURE INTERPOLEE                                    MAIN
C     NORM   BLOC DES GRADIENTS POUR TOUT LES INTERVALLES DU PROFIL     MAIN
C        GR   GRADIENT                                                  MAIN
C        GRDNOR   GRADIENT NORMALISE                                    MAIN
C     SORT   BLOC DES DONNEES POUR CHAQUE SOUS-STRUCTURE                MAIN
C        ITYPE   TYPE DE SOUS-STRUCTURE(1=THERMOCLINE,2=INVERSION)      MAIN
C        ZDEB   PROFONDEUR DU DEBU DE LA SOUS-STRUCTURE                 MAIN
C        EPAIS   EPAISSEUR                                              MAIN
C        NPT   NOMBRE D'INTERVALLES                                     MAIN
C        GRS   GRADIENT                                                 MAIN
C        GRSNOR   GRADIENT NORMALISE                                    MAIN
C        TEMP   TEMPERATURE AU DEBU DE LA SOUS-STRUCTURE                MAIN
C     ENTET   ENTETE DE STATION DANS OCEANS                             MAIN
C        ICRN   NUMERO D'EXPEDITION                                     MAIN
C        ISTN   NUMERO DE STATION                                       MAIN
C        LAH,LAT   HEMISPHERE ET VALEUR DE LATITUDE                     MAIN
C        LOH,LON   HEMISPHERE ET VALEUR DE LONGITUDE                    MAIN
C        IAN,MOIS,JOUR,IHEURE   DATE ET HEURE DU PROFIL                 MAIN
C        NIVEAUX   NOMBRE DE NIVEAUX ENREGISTRES DANS OCEANS            MAIN
C        INFO   DONNEES DE METEO (VOIR OCEANS)                          MAIN
C                                                                       MAIN
      COMMON/INDAT/Z(99),T(99)/INTDAT/TO(500)/GRADI/GR(500)             MAIN
      COMMON/NORMAL/GRDNOR(500)                                         MAIN
      COMMON/SORT/ITYPE(20),ZDEB(20),EPAIS(20),NPT(20),GRS(20,100),GRSNO MAIN
     2R(20,100),TEMP(20)                                                MAIN
      COMMON/ENTET/ICRN,ISTN,LAH,LAT,LOH,LON,IAN,MOIS,JOUR,IHEURE,NIVEAU MAIN
     2X,INFO(4)                                                         MAIN
      REAL MINORM                                                       MAIN
C                                                                       MAIN
C     LIRE CONTROLES                                                    MAIN
C                                                                       MAIN
C     DEFINITION DES CONTROLES                                          MAIN
C        DINTER   INTERVALLE DE PROFONDEUR POUR L'INTERPOLATION         MAIN
C        DBINTER   DEBUT DE L'INTERPOLATION                             MAIN
C        FINTER   FIN DE L'INTERPOLATION                                MAIN
C        IOPT1   INDIQUE SI L'OPTION 1 EST DESIREE(0=NON,1=OUI)         MAIN
C        IOPT2,IOPT3   PAREIL POUR LES OPTIONS 2 ET 3                   MAIN
C        MINORM   VALEUR MINIMUM DE GRADIENT MOYEN ACCEPTABLE           MAIN
C        RMIN   GRADIENT NORMALISE MAXIMUM DEFINISSANT UNE THERMOCLINE  MAIN
C        RMAX   GRADIENT NORMALISE MINIMUM DEFINISSANT UNE INVERSION    MAIN
C                                                                       MAIN
      READ(1,10)DINTER,DBINTER,FINTER                                   MAIN
   10 FORMAT(3F5.1)                                                     MAIN
```

```
      READ(1,11)IOPT1,IOPT2,IOPT3,MINORM,RMIN,RMAX
   11 FORMAT(3I1,3F4.2)
C
C     LIRE UN PROFIL
C
  100 CALL LECPROF(IFDF)
      IF(IFDF.EQ.1) STOP
C
C     CALCULER LE CARRE COTED
C
      CALL COTED(LAT,LON,ICOTED)
C
C     INTERPOLATION A INTERVALLES CONSTANTS DE PROFONDEUR
C
C     DEFINITIONS
C        NINT   NOMBRE DE VALEURS INTERPOLEES
C        NDEB   INTERVALLE OU LE PROFIL DEBUTE
C
      CALL INTERP(DINTER,DBINTER,FINTER,NIVEAUX,NINT,NDEB)
      IF(NINT.LE.1) GO TO 100
C
C     CALCULER LES GRADIENTS
C
C     DEFINITIONS
C        SUMGRA    SOMME DES GRADIENTS
C        SUMGRAB    SOMME DE LA VALEUR ABSOLUE DES GRADIENTS
C        SUMGRA2    SOMME DES CARRES DES GRADIENTS
C        Z01,Z02    PROFONDEURS D'INTERPOLATION
C        GRADMO    GRADIENT MOYEN
C        ABSMOY    MOYENNE DES GRADIENTS ABSOLUS
C        VARMOY    ECART-TYPE
C
      CALL GRAD(NINT,DINTER,DBINTER,NDEB,GRADMO,ABSMOY,VARMOY)
C
C     NORMALISATION PAR OPTION
C
      NT=NINT-1
  300 IF(IOPT1.EQ.0) GO TO 350
      IF(ABS(GRADMO).GE.MINORM) GO TO 310
      CALL ECRIT(ICOTED,DINTER,DBINTER,FINTER,NDEB,1,GRADMO,0,RMIN,RMAX,
     20,0)
      GO TO 350
  310 CALL NORM (GRADMO,NT)
      CALL DEFIN(NT,NTHR,NINV,DBINTER,DINTER,NDEB,RMIN,RMAX)
      CALL ECRIT(ICOTED,DINTER,DBINTER,FINTER,NDEB,1,GRADMO,1,RMIN,RMAX,
     2NTHR,NINV)
  350 IF(IOPT2.EQ.0) GO TO 400
      IF(ABSMOY.GE.MINORM) GO TO 360
      CALL ECRIT(ICOTED,DINTER,DBINTER,FINTER,NDEB,2,ABSMOY,0,RMIN,RMAX,
     20,0)
      GO TO 400
  360 CALL NORM(ABSMOY,NT)
      CALL DEFIN(NT,NTHR,NINV,DBINTER,DINTER,NDEB,RMIN,RMAX)
      CALL ECRIT(ICOTED,DINTER,DBINTER,FINTER,NDEB,2,ABSMOY,1,RMIN,RMAX,
     2NTHR,NINV)
  400 IF(IOPT3.EQ.0) GO TO 100
      IF(VARMOY.GE.MINORM) GO TO 410
      CALL ECRIT(ICOTED,DINTER,DBINTER,FINTER,NDEB,3,VARMOY,0,RMIN,RMAX,
     20,0)
      GO TO 100
  410 CALL NORM(VARMOY,NT)
      CALL DEFIN(NT,NTHR,NINV,DBINTER,DINTER,NDEB,RMIN,RMAX)
      CALL ECRIT(ICOTED,DINTER,DBINTER,FINTER,NDEB,3,VARMOY,1,RMIN,RMAX,
     2NTHR,NINV)
      GO TO 100
      END
```

Appendix III

Format of the Control Cards

1. Interpolation control card

Field	Columns	Format	Description
1	1 - 5	F5.1	Interpolation increment
2	6 - 10	F5.1	Beginning of interpolation
3	11 - 15	F5.1	End of interpolation

2. Control card for the calculation and validation of the gradients

Field	Columns	Format	Description
1	1	I1	Option 1 (0 = no; 1 = yes)
2	2	I1	Option 2 (0 = no; 1 = yes)
3	3	I1	Option 3 (0 = no; 1 = yes)
4	4 - 7	I4	Minimum valid value for the gradient to the hundredth of a °C/m
5	8 - 11	I4	Maximum value of a normalized gradient defining a thermocline to the hundredth
6	12 - 15	I4	Minimum value of a normalized gradient defining an inversion, to the hundredth

Appendix IV

```
SUBROUTINE LECPROF    74/74    OPT=1                    FTN 4.6+446        27/02/79  08.38.37

      SUBROUTINE LECPROF(IFDF)
C
C     LIT UN PROFIL DANS LE FORMAT OCEANS
C     (SWEERS,H.E.,1970. OCEANS IV. ENERGY,MINES AND RESOURCES,MARINE
C     SCIENCE BRANCH,MS. REPT. SER. NO. 15)
C
C
C     J. NASR, SOMM, 17 FEVRIER 1976
C     LIRE LA DEFINITION DES TERMES DANS LE PROGRAMME PRINCIPAL, EXCEPTE
C     POUR LES NOMS SUIVANTS
C        IN   VARIABLE D'ENTREPOSAGE A LA SUITE D'UNE LECTURE
C        IFDF   INDEX DE FIN-DE-FICHIER
C     ITYPE   TYPE DE FICHE LOGIQUE DANS OCEANS
C
      DIMENSION IN(8)
      COMMON/INDAT/Z(99),T(99)
      COMMON/ENTET/ICRN,ISTN,LAH,LAT,LOH,LON,IAN,MOIS,JOUR,IHEURE,NIVEAU
     2X,INFO(4)
  100 READ(3,10)IN
   10 FORMAT(8A10)
      IF(EOF(3))110,200
  110 IFDF=1
      RETURN
  200 CONTINUE
      DECODE(10,11,IN(8))ITYPE
   11 FORMAT(9X,I1)
      IF(ITYPE.EQ.1) GO TO 100
      IF(ITYPE.EQ.2) GO TO 300
      WRITE(2,12)
   12 FORMAT(1H1,T10,*- - -ERREUR DANS SOUS-ROUTINE LECPROF- - -*/T10,*-
     2 - -PREMIERE FICHE NON DE TYPE 2- - - *)
      IFDF=1
      RETURN
  300 CONTINUE
C
C     DECODER LA FICHE D'ENTETE
C
      DECODE(80,13,IN)ICRN,ISTN,LAH,LAT,LOH,LON,IAN,MOIS,JOUR,IHEURE,NIV
     2EAUX,INFO
   13 FORMAT(I9,I3,A1,I6,A1,I7,3I2,I4,I2,4A10,1X)
C
C     LIRE LES FICHES DE NIVEAUX
C
      DO 400 N=1,NIVEAUX
      READ(3,10)IN
      IF(EOF(3))310,320
  310 WRITE(2,14)
   14 FORMAT(1H1,T10,*- - -FIN DE FICHIER PREMATUREE- - -*)
      IFDF=1
      RETURN
  320 DECODE(10,11,IN(8))ITYPE
      IF(ITYPE.EQ.3)GO TO 330
      WRITE(2,15)
   15 FORMAT(1H1,T10,*- - -FICHE DE TYPE NON 3 AVANT NOMBRE DE NIVEAUX D
     2ECRITS- - -*)
      IFDF=1
      RETURN
  330 DECODE(80,16,IN)Z(N),T(N)
   16 FORMAT(16X,F5.1,6X,F5.3,48X)
  400 CONTINUE
      IFDF=0
      RETURN
      END
```

Appendix V

```
SUBROUTINE INTERP     74/74    OPT=1                          FTN 4.6+446        27/02/79  08.38.37

      SUBROUTINE INTERP(DINTER,DBINTER,FINTER,NIVEAUX,NINT,NDEB)
C
C     INTERPOLLE LA TEMPERATURE A INTERVALLES CONSTANTS DE PROFONDEUR
C
C     VOIR LA DEFINITION DES TERMES DANS LE PROGRAMME PRINCIPAL
C
      DIMENSION ZO(500)
      COMMON/INDAT/Z(99),T(99)/INTDAT/TO(500)
      NINT=0
C
C     DETERMINE LA PREMIERE PROFONDEUR D'INTERPOLATION
C
      IF(Z(NIVEAUX).LE.DBINTER) RETURN
      IF(Z(1).LE.DBINTER) GO TO 200
      ZO(1)=IFIX(Z(1)/DINTER)*DINTER
      IF(ZO(1).LT.Z(1))ZO(1)=ZO(1)+DINTER
      NDEB=(ZO(1)-DBINTER)/DINTER+1
      GO TO 300
  200 ZO(1)=DBINTER
      NDEB=1
C
C
C     DETERMINE LE NOMBRE DE NIVEAUX A INTERPOLER
C
  300 IF(Z(NIVEAUX).GE.FINTER) GO TO 310
      NINT=IFIX((Z(NIVEAUX)-ZO(1))/DINTER)+1
      GO TO 320
  310 NINT=IFIX((FINTER-ZO(1))/DINTER)+1
C
C     INTERPOLATION
C
  320 N=1
      I=1
  350 IF(Z(I).GE.ZO(N)) GO TO 360
      I=I+1
      GO TO 350
  360 IF(Z(I).EQ.ZO(N)) GO TO 370
      TO(N)=T(I-1)+((T(I)-T(I-1))*(ZO(N)-Z(I-1))/(Z(I)-Z(I-1)))
      GO TO 380
  370 TO(N)=T(I)
  380 N=N+1
      IF(N.GT.NINT) RETURN
      ZO(N)=ZO(1)+N*DINTER-DINTER
      GO TO 350
      END
```

Appendix VI

```
SUBROUTINE GRAD        74/74    OPT=1                    FTN 4.6+446        27/02/79  08.38.37

      SUBROUTINE GRAD(NINT,DINTER,DBINTER,NDEB,GRADMO,ABSMOY,VARMOY)
C
C     CALCULE LES GRADIENTS DE TEMPERATURE D'UN PROFIL AINSI QUE LES
C     MOYENNES
C
C     DEFINITION DES VARIABLES DANS LE PROGRAMME PRINCIPAL
C
C     FEVRIER 1978, DETACHE DU PROGRAMME PRINCIPAL, J. NASR
C
      COMMON/INTDAT/TO(500)/GRADI/GR(500)
      SUMGRA=0
      SUMGRAB=0
      SUMGRA2=0
      DO 100 I=2,NINT
      Z01=(I+NDEB-3)*DINTER+DBINTER
      Z02=(I+NDEB-2)*DINTER+DBINTER
      K=I-1
      GR(K)=(TO(I)-TO(I-1))/(Z02-Z01)
      SUMGRA=SUMGRA+GR(K)
      SUMGRAB=SUMGRAB+ABS(GR(K))
  100 SUMGRA2=SUMGRA2+GR(K)*GR(K)
      NT=NINT-1
      GRADMO=SUMGRA/NT
      ABSMOY=SUMGRAB/NT
      IF(NT.LE.2) GO TO 110
      VARMOY=SQRT(ABS((SUMGRA2*NT)-(SUMGRA*SUMGRA))/(NT*(NT-1)))
      GO TO 120
  110 VARMOY=0
  120 CONTINUE
      RETURN
      END
```

Appendix VII

```
SUBROUTINE NORM        74/74    OPT=1                    ETN 4.6+446        27/02/79  08.38.37

                SUBROUTINE NORM(AMOY,NT)                                        NORMAL      2
          C                                                                     NORMAL      3
          C     NORMALISE LES GRADIENTS                                         NORMAL      4
          C     AMOY EST LA MOYENNE SELON L'OPTION ELUE                         NORMAL      5
          C     FEVRIER 1978, DETACHEE DU PROGRAMME PRINCIPAL, J. NASR          NORMAL      6
          C                                                                     NORMAL      7
                COMMON/GRADI/GR(500)/NORMAL/GRDNOR(500)                         NORMAL      8
                DO 100 I=1,NT                                                   NORMAL      9
            100 GRDNOR(I)=GR(I)/AMOY                                            NORMAL     10
                RETURN                                                          NORMAL     11
                END                                                             NORMAL     12
```

Appendix VIII

```
SUBROUTINE DEFIN      74/74   OPT=1                          FTN 4.6+446        27/02/79  08.38.37

      SUBROUTINE DEFIN(NT,NTHR,NINV,DBINTER,DINTER,NDEB,AMIN,AMAX)
C
C     DEFINIE LES STRUCTURES THERMIQUES ET LEURS CARACTERISTIQUES
C
C     VOIR DEFINITION DES TERMES DANS LE PROGRAMME PRINCIPAL EXCEPTE
C     POUR LES TERMES SUIVANTS
C     NTHR   NOMBRE DE THERMOCLINES
C     NINV   NOMBRE D'INVERSIONS
C
      COMMON/GRADI/GR(500)/NORMAL/GRDNOR(500)
      COMMON/SORT/ITYPE(20),ZDEB(20),EPAIS(20),NPT(20),GRS(20,100),GRSNO
     2R(20,100),TEMP(20)
      COMMON/INTDAT/TO(500)
      I=1
      N=0
      NTHR=0
      NINV=0
      RMIN=AMIN-1.E-3
      RMAX=AMAX+1.E-3
  100 IF(GRDNOR(I).GT.RMIN.AND.GRDNOR(I).LT.RMAX) GO TO 110
      GO TO 120
  110 I=I+1
      IF(I.GT.NT) RETURN
      GO TO 100
  120 N=N+1
      IF(GRDNOR(I).LE.RMIN) GO TO 210
  200 NINV=NINV+1
      ITYPE(N)=2
      GO TO 230
  210 NTHR=NTHR+1
      ITYPE(N)=1
  230 NPT(N)=1
      NB=NPT(N)
      ZDEB(N)=DBINTER+(NDEB+I-2)*DINTER
      TEMP(N)=TO(I)
  250 GRS(N,NB)=GR(I)
      GRSNOR(N,NB)=GRDNOR(I)
      I=I+1
      IF(I.LE.NT) GO TO 280
      EPAIS(N)=NPT(N)*DINTER
      RETURN
  280 IF(ITYPE(N).EQ.2) GO TO 400
  300 IF(GRDNOR(I).GT.RMIN) GO TO 320
  310 NPT(N)=NPT(N)+1
      NB=NPT(N)
      GO TO 250
  320 IF(GRDNOR(I).GE.RMAX) GO TO 350
  330 EPAIS(N)=NPT(N)*DINTER
      GO TO 110
  350 EPAIS(N)=NPT(N)*DINTER
      N=N+1
      GO TO 200
  400 IF(GRDNOR(I).LT.RMAX) GO TO 420
      GO TO 310
  420 IF(GRDNOR(I).GT.RMIN) GO TO 330
      EPAIS(N)=NPT(N)*DINTER
      N=N+1
      GO TO 210
      END
```

Appendix IX

```
SUBROUTINE ECRIT      74/74   OPT=1                          FTN 4.6+446        27/02/79  08.38.37

      SUBROUTINE ECRIT(ICOTED,DINTER,DBINTER,FINTER,NDEB,IOPT,GMOY,INDIC ECRIT      2
     2,RMIN,RMAX,NTHR,NINV)                                              ECRIT      3
C                                                                        ECRIT      4
C     CREE LE FICHIER INTERMEDIAIRE                                      ECRIT      5
C                                                                        ECRIT      6
      DIMENSION IOUT(102)                                                ECRIT      7
      DIMENSION IGRS(100),IGRSNOR(100)                                   ECRIT      8
      COMMON/ENTET/ICRN,ISTN,LAH,LAT,LOH,LON,IAN,MOIS,JOUR,IHEURE,NIVEAU ECRIT      9
     2X,INFO(4)                                                          ECRIT     10
      COMMON/SORT/ITYPE(20),ZDEB(20),EPAIS(20),NPT(20),GRS(20,100),GRSNO ECRIT     11
     2R(20,100),TEMP(20)                                                 ECRIT     12
      DATA(ITYPE2=2)                                                     ECRIT     13
      INTER=DINTER*10                                                    ECRIT     14
      IDB=DBINTER*10                                                     ECRIT     15
      IFIN=FINTER*10                                                     ECRIT     16
      MOY=GMOY*100                                                       ECRIT     17
      MIN=RMIN*10                                                        ECRIT     18
      MAX=RMAX*10                                                        ECRIT     19
      ENCODE(130,10,IOUT)ICRN,ISTN,LAH,LAT,LOH,LON,IAN,MOIS,JOUR,IHEURE, ECRIT     20
     2NIVEAUX,INFO,ITYPE2,ICOTED,INTER,IDB,IFIN,NDEB,IOPT,MOY,INDIC,MIN, ECRIT     21
     3MAX,NTHR,NINV                                                      ECRIT     22
   10 FORMAT(I9,I3,A1,I6,A1,I7,3I2,I4,I2,4A10,I1,I6,I4,2I5,I2,I1,I5,I1,  ECRIT     23
     22I4,2I3,7X)                                                        ECRIT     24
      BUFFER OUT(4,0)(IOUT(1),IOUT(13))                                  ECRIT     25
      IF(UNIT(4))100,900,800                                             ECRIT     26
  100 IF(INDIC.EQ.0) RETURN                                              ECRIT     27
      NT=NTHR+NINV                                                       ECRIT     28
      NINV2=0                                                            ECRIT     29
      NTHR2=0                                                            ECRIT     30
      DO 200 N=1,NT                                                      ECRIT     31
      LONG=2*NPT(N)*5+40                                                 ECRIT     32
      MOTS=LONG/10                                                       ECRIT     33
      IZDEB=ZDEB(N)*10                                                   ECRIT     34
      IEPAIS=EPAIS(N)*10                                                 ECRIT     35
      NPOINT=NPT(N)                                                      ECRIT     36
      ITEMP=TEMP(N)*1000                                                 ECRIT     37
      DO 105 I=1,NPOINT                                                  ECRIT     38
      IGRS(I)=GRS(N,I)*100                                               ECRIT     39
  105 IGRSNOR(I)=GRSNOR(N,I)*100                                         ECRIT     40
      IF(ITYPE(N).EQ.2) GO TO 110                                        ECRIT     41
      NTHR2=NTHR2+1                                                      ECRIT     42
      IORDR=NTHR2                                                        ECRIT     43
      GO TO 120                                                          ECRIT     44
  110 NINV2=NINV2+1                                                      ECRIT     45
      IORDR=NINV2                                                        ECRIT     46
  120 ENCODE(150,11,IOUT)ICRN,ISTN,ITYPE(N),IORDR,IZDEB,NPOINT,IEPAIS,IT ECRIT     47
     2EMP,(IGRS(I),I=1,NPOINT),(IGRSNOR(J),J=1,NPOINT)                   ECRIT     48
   11 FORMAT(I9,I3,I1,I2,I6,I3,2I5,1X,23I5,6(/,30I5))                    ECRIT     49
      BUFFER OUT(4,0)(IOUT(1),IOUT(MOTS))                                ECRIT     50
      IF(UNIT(4))200,900,800                                             ECRIT     51
  200 CONTINUE                                                           ECRIT     52
      RETURN                                                             ECRIT     53
  800 WRITE(2,13)                                                        ECRIT     54
   13 FORMAT(1H1,T10,*- - -ERREUR DE PARITE SUR LE RUBAN DE SORTIE- - -* ECRIT     55
     2)                                                                  ECRIT     56
      STOP                                                               ECRIT     57
  900 WRITE(2,14)                                                        ECRIT     58
   14 FORMAT(1H1,T10,*- - -FIN DE FICHIER SUR LE RUBAN DE SORTIE- - -*)  ECRIT     59
      STOP                                                               ECRIT     60
      END                                                                ECRIT     61
```